

# Constraints on precipitation microphysics from cold-season ground validation observations

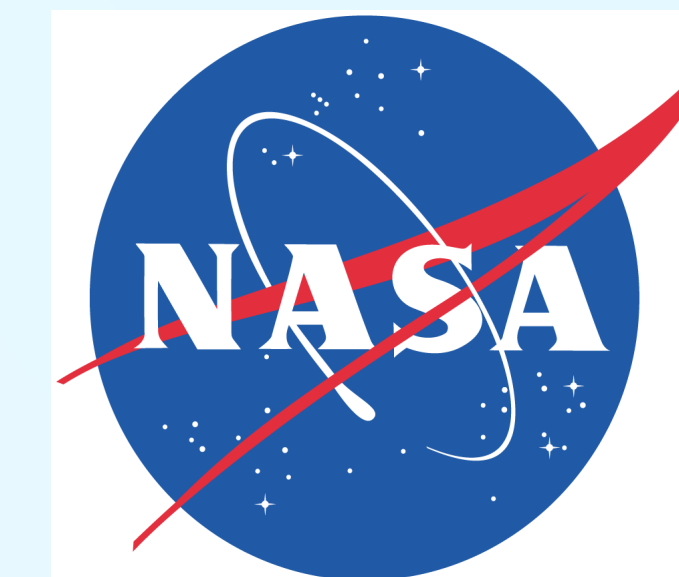


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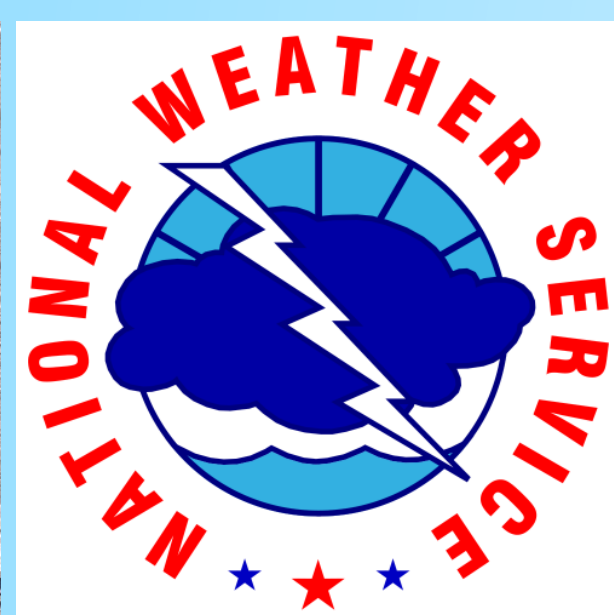
With contributions from: Mark Kulie<sup>1</sup>, Walter Petersen<sup>2</sup>, and Larry Bliven<sup>2</sup>

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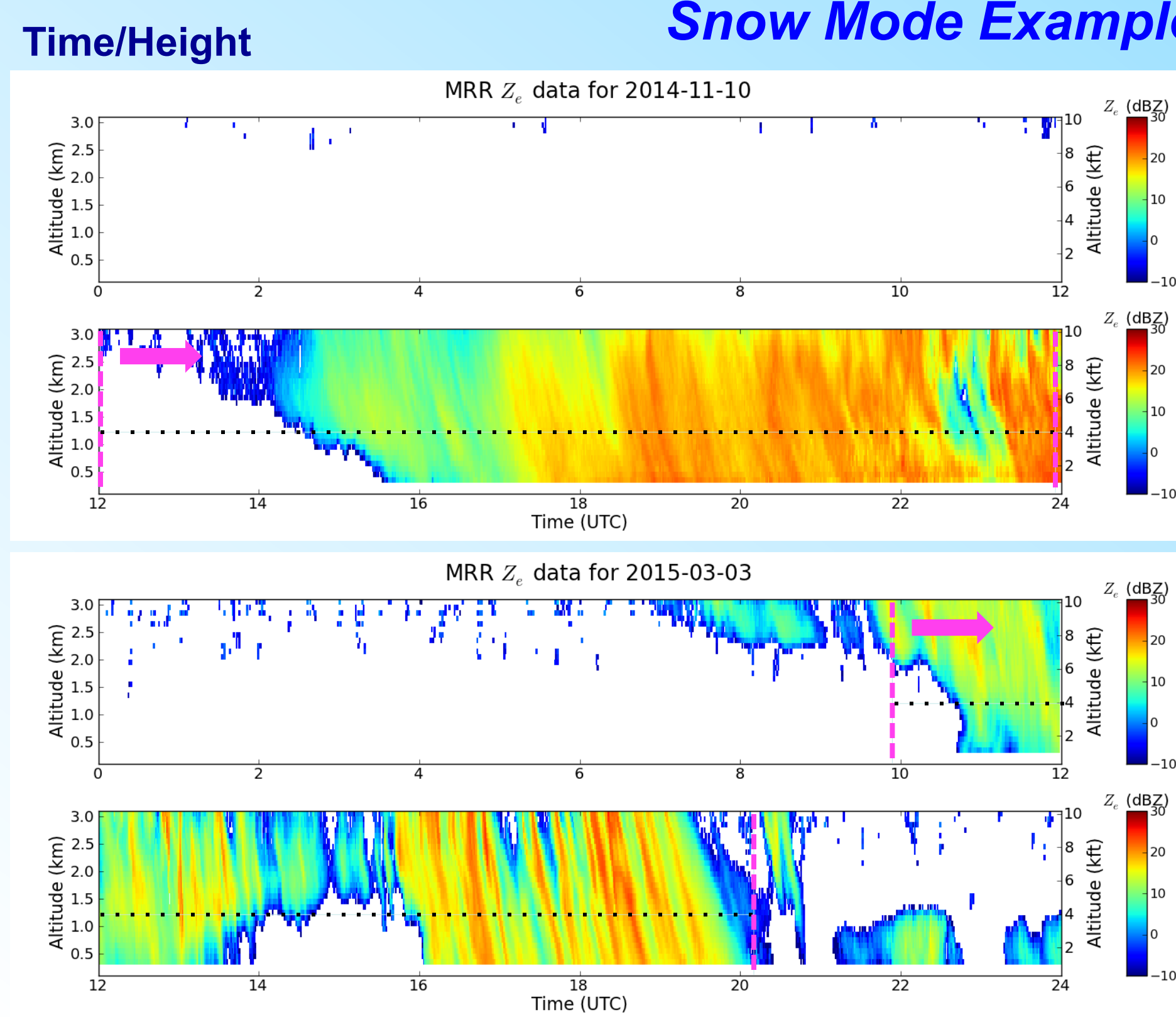


- MicroRain Radar profiles show characteristics that tie to differences in meteorological forcing, which seem consistent at different sites
- Microphysical retrievals on Ground Validation observations will allow us to relate these radar classifications to the underlying microphysical properties
- Tying remotely-sensed radar profiles to these proto-typical histograms (CFADs) should allow improved *a priori* assumptions in radar-based retrieval algorithms



## Marquette Michigan Instrument Suite – MicroRain Radar

### Snow Mode Examples: Synoptic

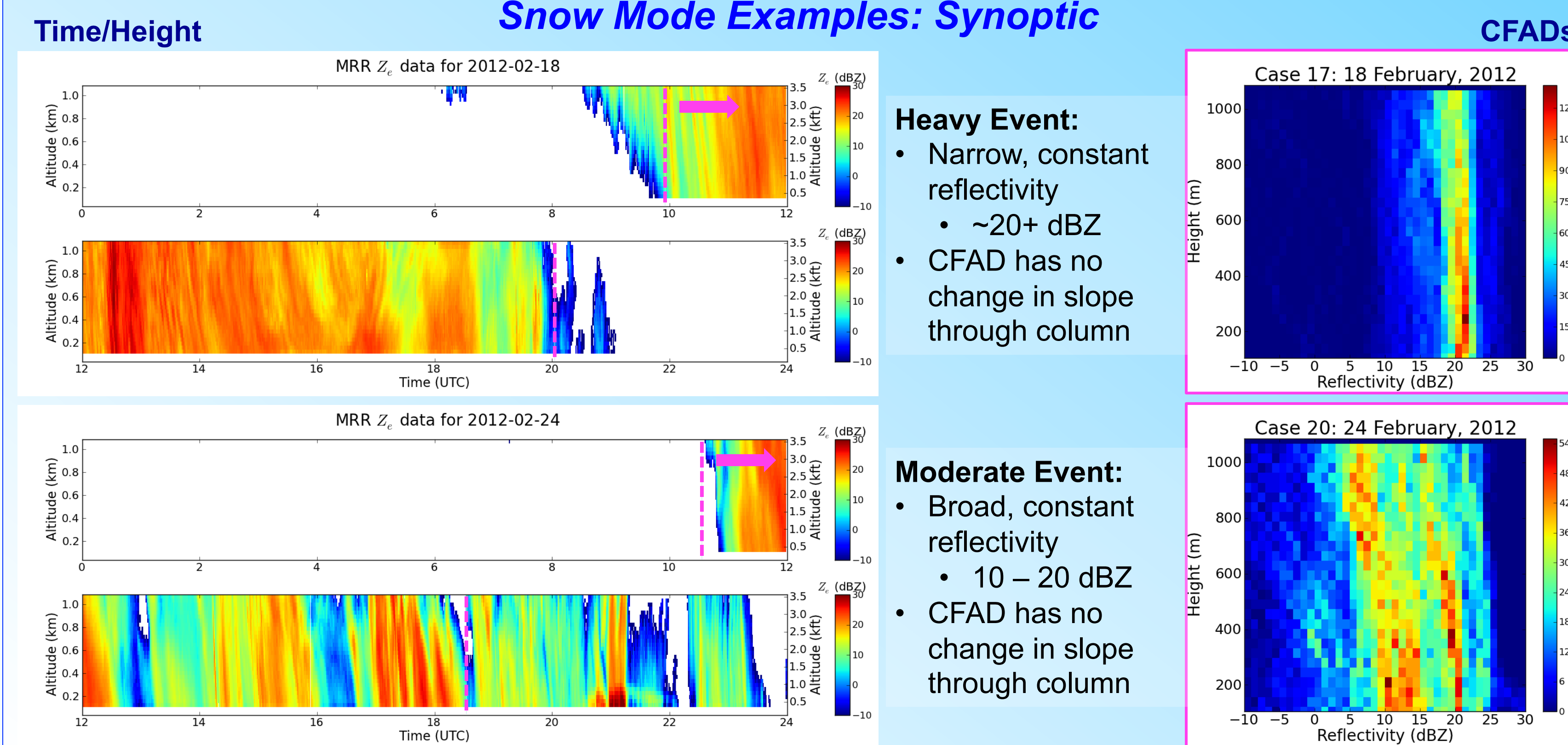


- Heavy Event:**
- Narrow, constant reflectivity
  - ~20 dBZ
  - CFAD has no change in slope through column

- Moderate Event:**
- Broad, constant reflectivity
  - ~12 dBZ
  - CFAD has no change in slope through column

## GCPEX CARE Instrument Suite – MicroRain Radar (EC)

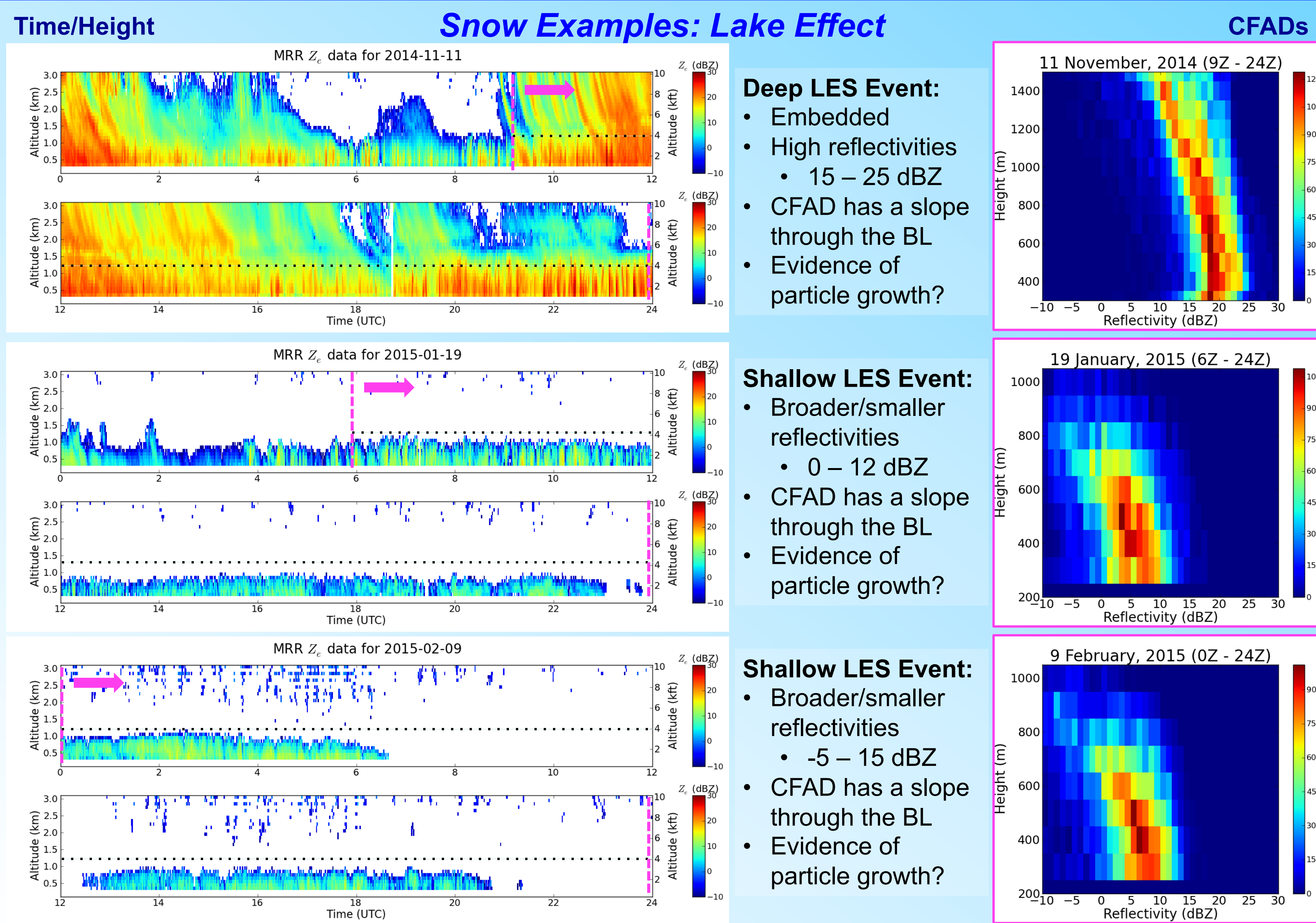
### Snow Mode Examples: Synoptic



- Heavy Event:**
- Narrow, constant reflectivity
  - ~20+ dBZ
  - CFAD has no change in slope through column

- Moderate Event:**
- Broad, constant reflectivity
  - 10 – 20 dBZ
  - CFAD has no change in slope through column

### Snow Examples: Lake Effect

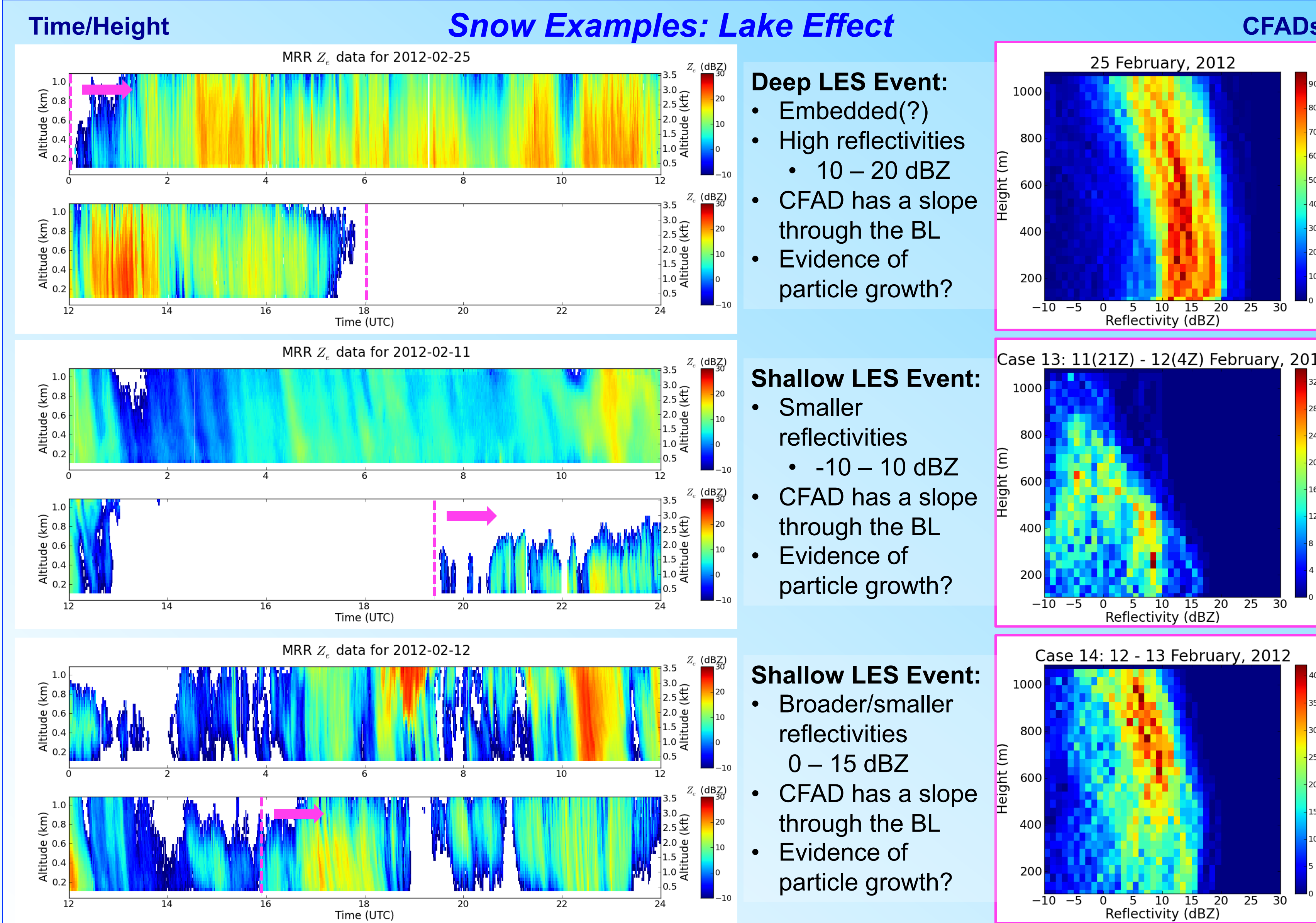


- Deep LES Event:**
- Embedded
  - High reflectivities
  - 15 – 25 dBZ
  - CFAD has a slope through the BL
  - Evidence of particle growth?

- Shallow LES Event:**
- Broader/smaller reflectivities
  - 0 – 12 dBZ
  - CFAD has a slope through the BL
  - Evidence of particle growth?

- Shallow LES Event:**
- Broader/smaller reflectivities
  - -5 – 15 dBZ
  - CFAD has a slope through the BL
  - Evidence of particle growth?

### Snow Examples: Lake Effect

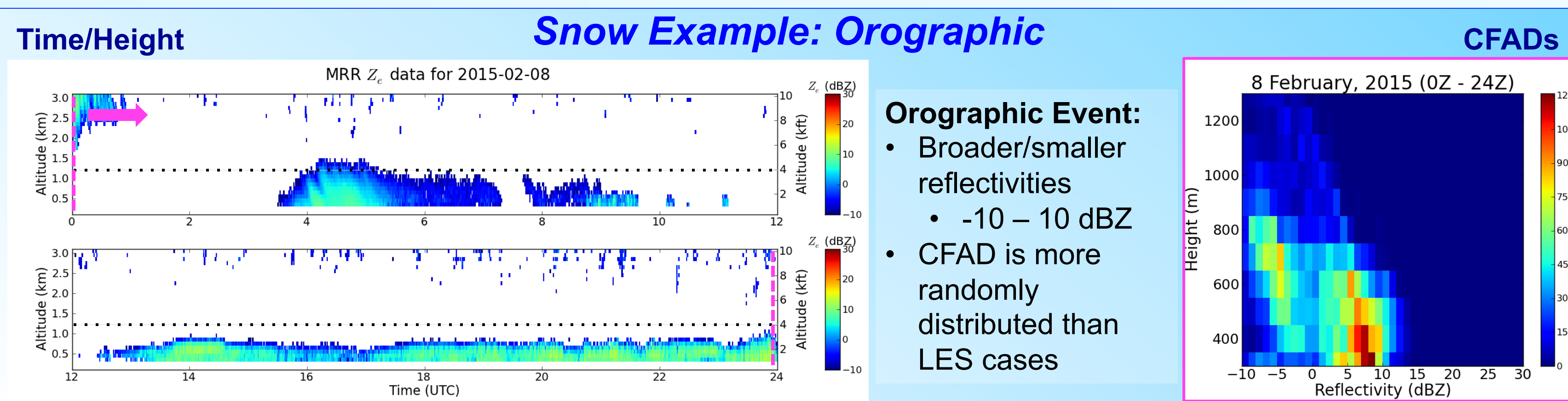


- Deep LES Event:**
- Embedded(?)
  - High reflectivities
  - 10 – 20 dBZ
  - CFAD has a slope through the BL
  - Evidence of particle growth?

- Shallow LES Event:**
- Smaller reflectivities
  - -10 – 10 dBZ
  - CFAD has a slope through the BL
  - Evidence of particle growth?

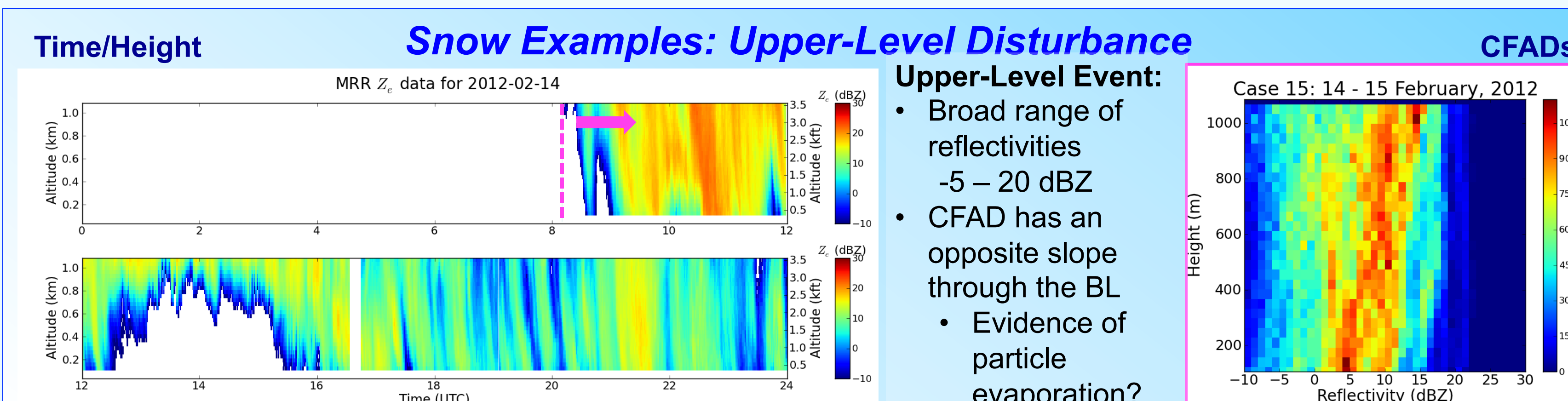
- Shallow LES Event:**
- Broader/smaller reflectivities
  - 0 – 15 dBZ
  - CFAD has a slope through the BL
  - Evidence of particle growth?

### Snow Example: Orographic



- Orographic Event:**
- Broader/smaller reflectivities
  - -10 – 10 dBZ
  - CFAD is more randomly distributed than LES cases

### Snow Examples: Upper-Level Disturbance



- Upper-Level Event:**
- Broad range of reflectivities
  - -5 – 20 dBZ
  - CFAD has an opposite slope through the BL
  - Evidence of particle evaporation?

## Microphysical properties from GV observations

Remote sensing techniques like optimal estimation can be used to 'retrieve' microphysical properties from near-surface observations.

For snow:

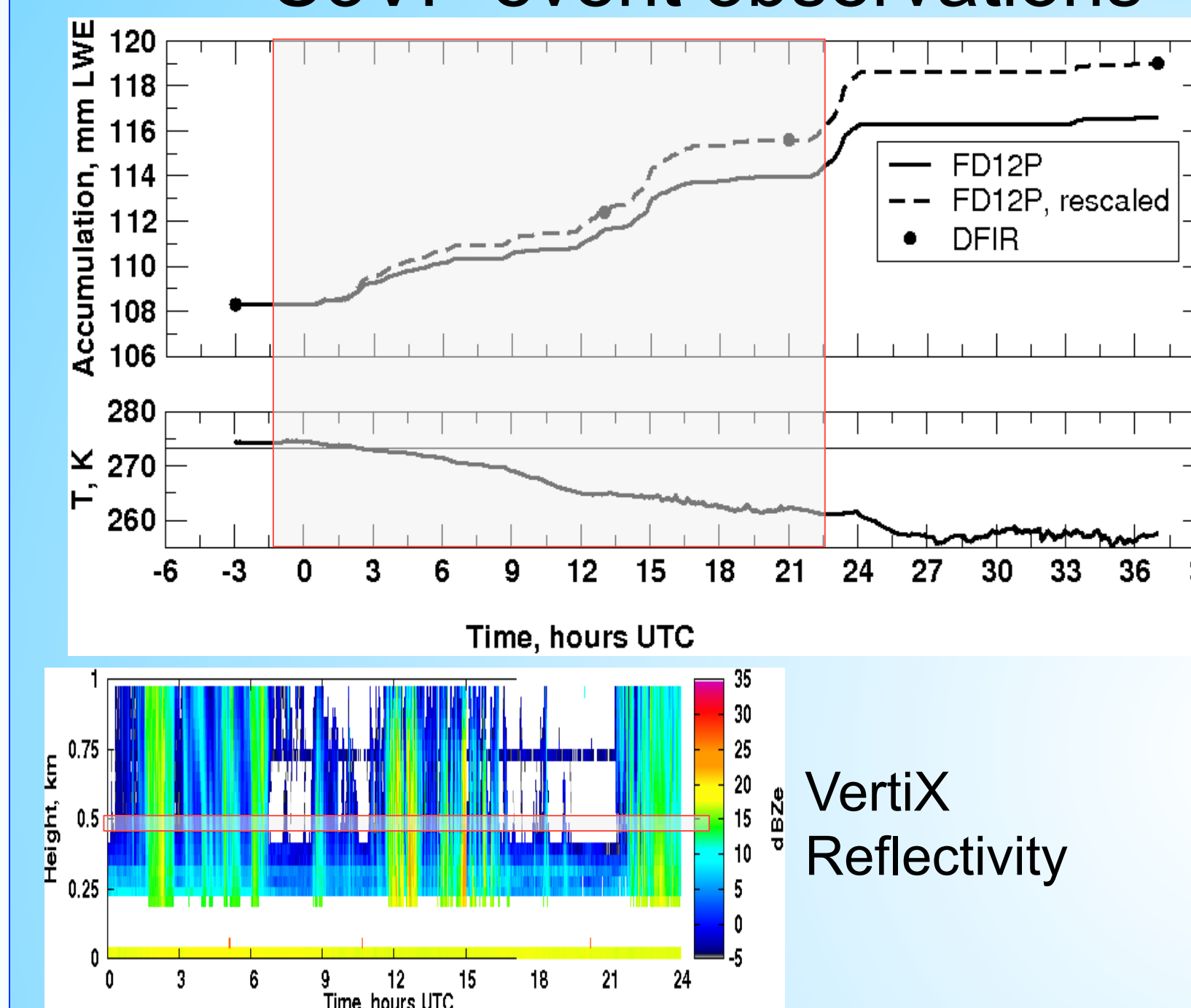
- N(D) (disdrometer)
- V(D) (disdrometer)
- Z<sub>e</sub> at range ~0 (radar)
- Precipitation rate (e.g., Pluvio)

$$m(D) = \alpha D^\beta$$

$$A_p(D) = \gamma D^\sigma$$

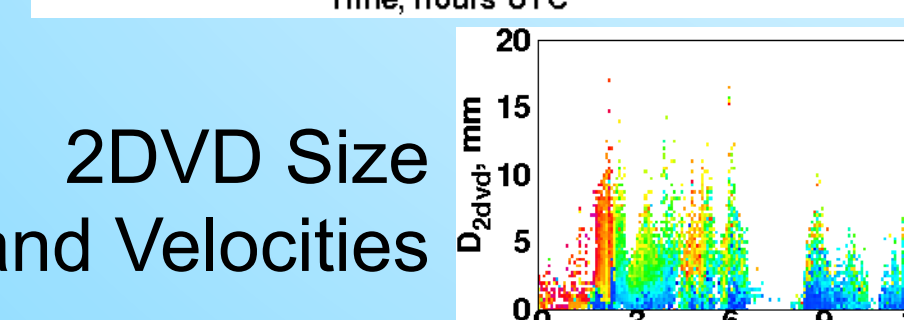
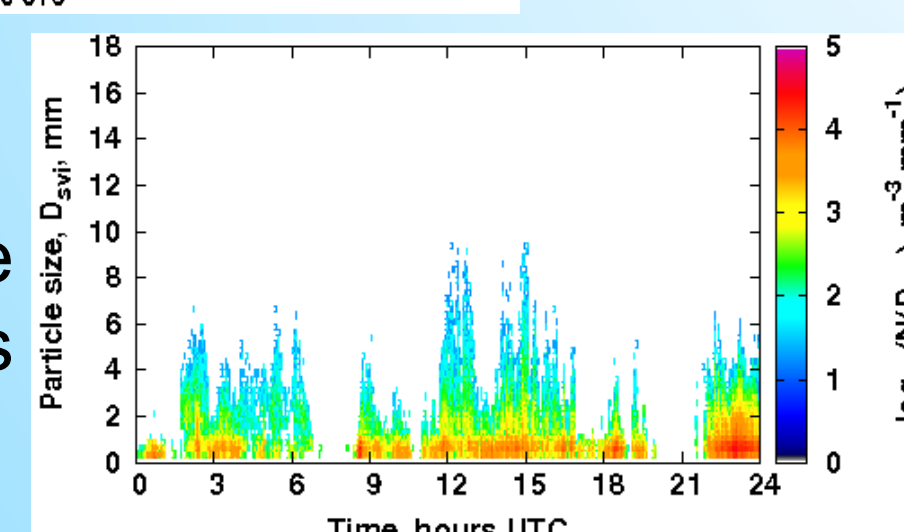
## Example:

### C3VP event observations



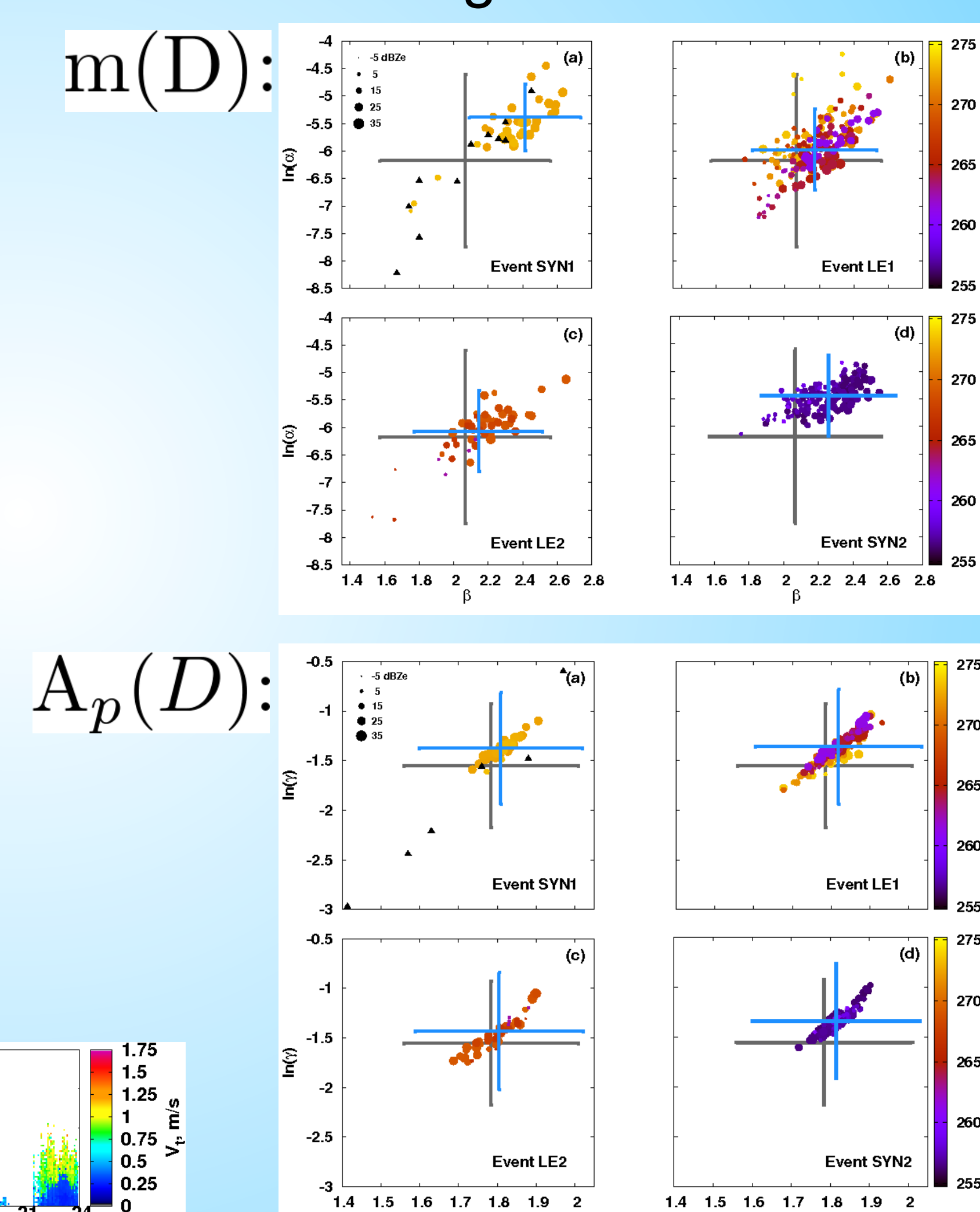
VertiX Reflectivity

SVI Size Distributions



## Results:

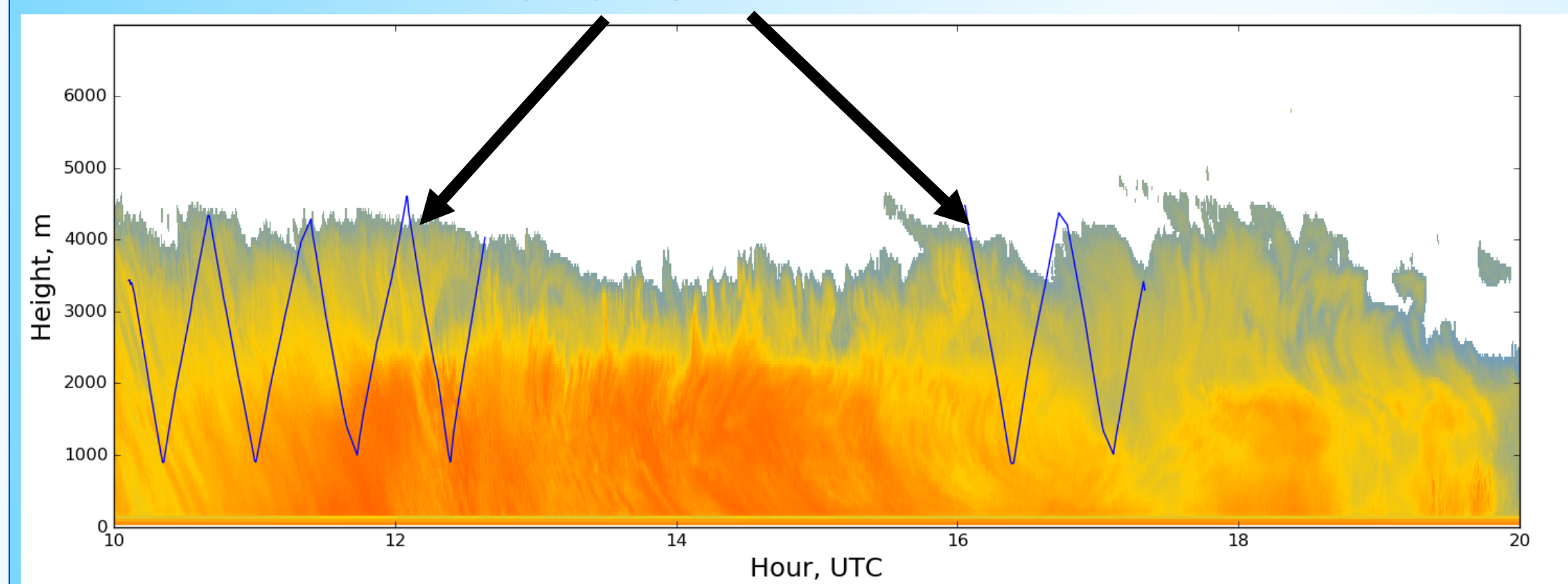
Parameters are sensitive to meteorological mechanism



## Extending with observations aloft:

GCPEX storm with *in situ* aircraft sampling

UND Citation tracks over CARE



At top of and within the column, UND Citation constrains

- N(D)
- IWC
- Perhaps A<sub>p</sub>(D)

Within column, radar constrains

- Z<sub>e</sub>(h)
- V<sub>dop</sub>(h)

At column base, ground observations constrain

- N(D)
- Pr

## Data and Science Resources

- Website with Quicklooks and Data Browser: [http://www.ssec.wisc.edu/lake\\_effect/mqgl/](http://www.ssec.wisc.edu/lake_effect/mqgl/)
- GCPEX MicroRain Radar Data: [ftp://qpm.ngscc.nasa.gov/qpm\\_validation/](ftp://qpm.ngscc.nasa.gov/qpm_validation/)
- NASA Support Provided by Grants: NNX16AE87G

## References:

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- Kulie, M. and Bennartz, R.: Utilizing Spaceborne Radars to Retrieve Dry Snowfall, J. Appl. Meteor. Climatol., 48, 2564–2580, 2009, doi: 10.1175/2009JAMC2193.1
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